KAROL SIEGL*

THE STRUCTURE OF THE LOW TATRA PLUTON (WEST CARPATHIANS)

(Fig. 1—14)

Abstract: The Low Tatra Variesan pluton is late synkinematic, catazonal and conform with the structure of the metamorphite mantle. By incorporation into the Alpine geosyncline it was rebuilt under the formation of new material and structural heterogeneity. Mesoscopic and macroscopic structures of primary and secondary origin are analysed and illustrated in maps and diagrams.

Резюме: Варисцийский плутон горной цепи Низкие Татры являєтся катазональным, позднесинкинематическим и конформным со строѐнием мантии метаморфитов. Вчленением в альпийскую геосинклиналь был плутон изменен с одновременным возникновлением новых материалов и гетерогенных структур. Мезоскопические и макроскопические структуры обоих орогенов изучались методом структурного анализа и графически внесены в карты.

1. *Introduction*

The northern and western part of the Low Tatra Ďumbier crystalline complex is built by granitoids. They make up an elongated pluton, occuping an area of approx. 200 km². It is surrounded on S by metamorphic rocks and covered on N by the envelope and nappe Mesozoic. The bulk of the pluton is made up of granites, granodiorites and quartz diorites (J. Koutek 1931) of absolute age 280—360 m. y. (J. Kantor 1959). Alpine deformation induced locally infolding of the Mesozoic as well as postcrystalline deformation (J. Koutek 1931). By post-Paleogene uplifting on the faults, a mountain chain reaching recently 2000 m had generated.

In spite of numerous geologic and montanistic works dealing with this area, references to the structure of the pluton are rare. They appear in the papers of J. Koutek (1931), V. Zoubek (1931, 1935, in T. Buday et al. 1961), V. Zoubek — D. Kubíny (1956), D. Kubíny (1956) and R. Kettner (1958). The necessity of basic informations on the structure of the Ďumbier crystalline complex lead during the last five year to the compilation of general tectonic map and the presented brief analysis of the pluton structure.

2. *Mesoscopic structures*

2.1 *Foliation of modal inhomogeneity*

The spatial distribution of the essential mineral components of granitoids is often inhomogenous. In the exposure and sample separate accumulation of dark (biotite) and light (feldspars, quartz) minerals can be observed. They make up more or less distinct anisotropic streaks, the orientation of which may be measured. These planar structures were denominated nongenetically as foliations of modal inhomogeneity (fig. 1). It has been established by microscopic analysis that granitoid anisotropy is not only a consequence of modal composition variations, but also of biotite shape arrangement (K. Siegl 1970). Biotite flakes are statistically always parallel with bands of different composition.

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Fig. 1. Foliations of modal inhomogeneity in an anisotropic granodiorite. Boulder in the valley Trangoška, S of Chopok (2023.3). Photo courtesy of O. Miko.

The density of mesoscopic foliation of anisotropic granitoids varies in mm-dm range. In macrodomains it is the only penetrative discontinuity of the pluton. Orientation of foliation is usually stable in mesoscopic domains. It might vary near of larger enclaves and owing to postcrystalline deformation. It uses to be parallel with the boundary of mesoscopic enclaves (fig. 2), and "flows round" the more isometric ones. Foliation is parallel also with progressive-metamorphic schistosity of the mantle migmatites and macroenclaves (fig. 6 and 7). The foliation of modal inhohomogeneity is often place of subsequent structure localization, as veins and joints. Destruction of the foliation is brought about particularly by blastesis of metasomatic feldspars and by postcrystalline deformation.

2.2 *Enclaves*

Enclave shape in granitoids depends particularly on the petrographic composition of the assimilated rocks. Fine-grained biotite quartz-rich gneisses and amphibolites form ellipsoidal enclaves, coarse-grained well schistose biotite, two-mica and hornblende gneisses form board and lense shaped enclaves (fig. 2 and 3). The found enclaves are of exogenous origin and their material is similar to the metamorphic rocks of the mantle. In addition to sharp bordered x e n o l i t h s also unsharply delimited s k i a l i t h s (fig. 4) and rare metasomatic brecciae appear.

It is evident from these cases that the shape and degree of enclave reworking is the function of the following factors: the primary microscopic and mesoscopic fabric of

Fig. 2. Biotite paragneiss enclave in an anisotropic granitoid (detail of fig. 3). In the basement foliation of modal inhomogeneity parallel with the schistosity of the enclave. The younger pegmatite vein is shifted by shear on the basic surface of the enclave.

the assimilated rocks, their mineral constitution and grain size, dimension of the enclave, the position in the granitoids and their petrographic characteristics. By this reason enclaves of various shapes and grade of reworking may be found side by side (e. g. in fig. 3). While some enclaves are almost totally assimilated and their schistosity goes gradually over into foliations of modal inhomogeneity of the host granitoids, other types are almost unaffected by assimilation and were more rigid during its action.

The shape of anisometric enclaves and their schistosity is in the majority of the cases parallel with the foliations of modal inhomogeneity. Conspicuous rotation of the enclave is rare and other evidence for higher mobility of the encompassing environment has not been found.

2.3 *Veins*

A p l i t e a n d p e g m a t i t e veins of 10 cm average thickness are most abundant. They are often oriented paralelly to the foliations of modal inhomogeneity. In some cases aplite veins parallel with the foliation were found older than the veins transversal to foliation.

The less abundant veins with chlorites and carbonates, as well as the a l b i t e v e i n s with epidote described by V. Z o u b e k (1931) are the youngest. They appear mainly in postcrystalline deformed domains, where they fill up the fractures in mylonites and ac-joints in the close vicinity. Thin albite veinlets with epidote are

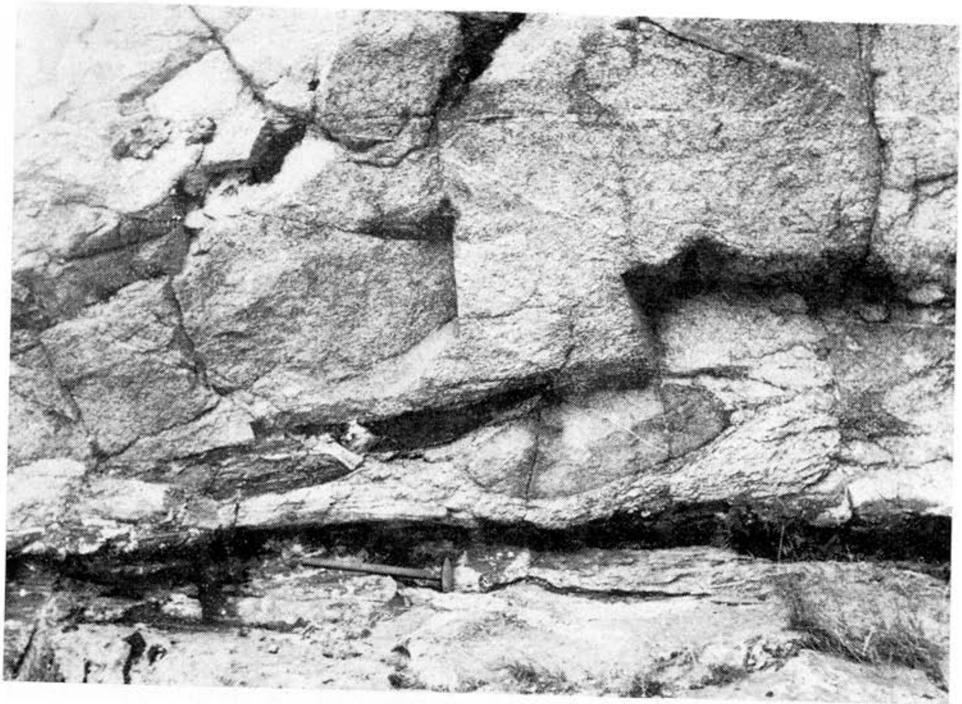

Fig. 3. Enclaves in anisotropic granitoid SE of Nižná Boca. The largest board-like enclave (on the site of the hammer) is mylonitized and reduced by shear parallel to its schistosity.

accompanied by albitization, zones of which are selectively weathered in the form of ribs (fig. 5). Several disjunctive dislocations are filled with ore veins of Fe, Cu, Sb, Au mineralization (vein deposits Magurka, Dúbrava and Ludárová hoľa). Their NW, NE, or ENE strike is similar like on the faults and joints generated in the Alpine deformation plane.

2.4 *Foliations of postcrystalline deformation*

In addition to fractures filled up with veins and numerous joints, foliations accompanied by cataclasis of the mineral components and their partial recrystallization prove for intensive postcrystalline deformation of the granitoids. These mesoscopic foliations do not appear as penetrative discontinuities in the whole pluton. They occur generally in the vicinity of faults. They are most abundant in phyllonites of fault zones, appear less frequently in mylonite and mortar gneisses and pass gradually into joints According to density their working denomination is spaced cleavage A (10-100/10 cm), and spaced cleavage B (0.5-10/10 cm).

In outcrops more distant from the fault a foliation set parallel with its plane may be found. In the fault zone also two conjugated sets appear forming an angle of 30° to 70°. With increasing deformation intensity sets grow into a single dominant. The orientation of secondary foliation of postcrystalline deformation is comparatively independent on foliation of modal inhomogeneity. Conform overprinting seems to be

Fig. 4. Skialith in Prašivá granite NE of Magurka. It has developed from a biotite paragneiss enclave by metasomatic crystallization of K-feldspars, which masked the primary anisotropy of encompassing granitoid.

in consequence of the local conformity of deformation planes and is not due to passive copying of the older anisotropy by shear.

The orientation of spaced cleavage A in the macrodomain is more stable than the orientation of spaced cleavage B (compare the diagrams in fig. 10 and 11). This is related with the fact that spaced cleavage A is the product of a dynamically and kinematically comparatively homogeneous deformation act, which is not valid for one part of spaced cleavage B.

2.5 *Joints*

Mesoscopic nonpenetrative fractures, devoid of visible cataclasis, mineral filling and usually of low density are designated as joints. Their orientation and quality of the surface are variable. Vertical and smooth joints without translation traces predominate. In microscopically analyzed granitoids (K. Siegl 1970) one part of the joints is parallel with the shape arrangement of biotite, however, also vertical and diagonal joints occur.

In strongly anisotropic granitoids the joints are more often vertical to the foliation of modal inhomogeneity as in the less anisotropic types. A mesoscopic criterion for "endogenous" and "exogenous" joints has not been established. In postcrystalline undeformed and deformed granitoids joint systems of identic orientation were found.

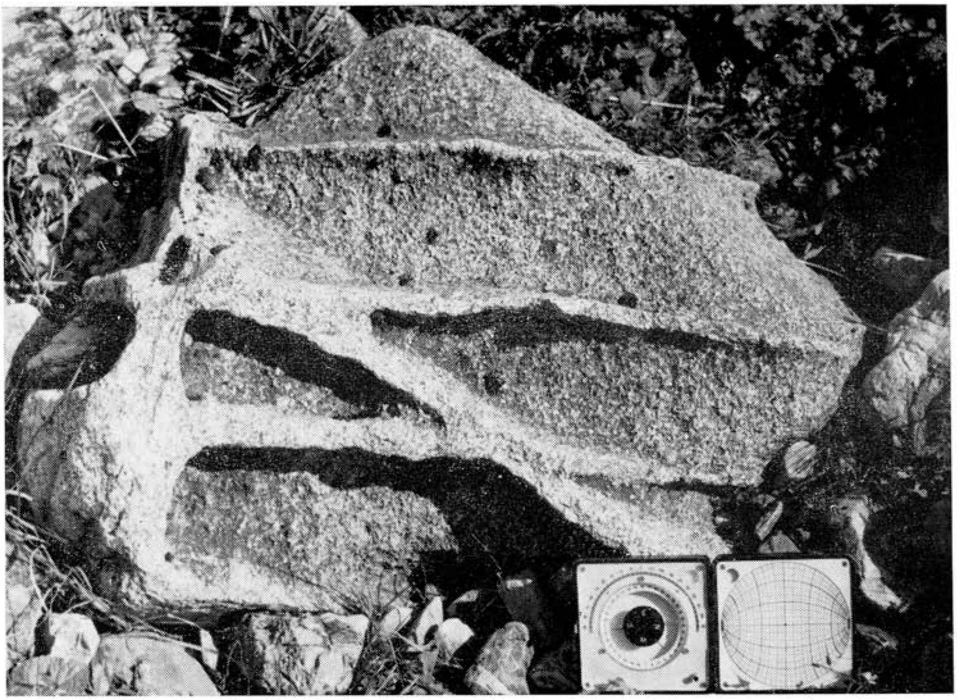

Fig. 5. Selective weathering of albitization zones in granitoids E of Tanečnica (1680,4).

3. *Macroscopic structures*

3.1 *The distribution and shape of material heterogeneity bodies*

For purpose of structural analysis two basic types of mesoscopically[1] isotropic and anisotropic granitoids have been distinguished in the pluton. They correspond by petrography to biotitic granites up to biotitic quartz diorites. Unlike the anisotropic types isotropic granitoids do not display any visible foliation of modal inhomogeneity. Lack of foliation is either primary, or secondary, due to camouflage by metasomatism.

The domains of isotropic granitoids cover the central, NW and W part of the pluton (see structural maps). The shape of the central domain follows approximately the pluton shape. It is situated asymmetrically and its width is $^1/_2$ to $^1/_3$ of the whole width of the pluton in the exposure plane. The extension and the shape of the NW and W domains are influenced by jounger metasomatism and faulting. The first veiled a part of the anisotropic domains, the second has rearranged, eventually reduced the domains.

The domains of anisotropic granitoids surround the central isotropic domain and build up the eastern part of the pluton. The northern zone is much wider than the southern one, likely owing to primary formation of the pluton and to secondary

[1] Biotite fabric in mesoscopically isotropic granitoids is also anisotropic (K. Siegl 1970).

Alpine reduction of the southern zone. The boundary of the isotropic and the anisotropic domains is unsharp. The density of modal inhomogeneity foliations of the anisotropic domains increases towards the pluton border. Its gradual transitions into the paleosom of the nebulitic and stromatic mantle migmatites and to large enclaves may be observed on several sites. Sharp boundaries between the mantle, the anisotropic and isotropic granitoid domains are usually of fault nature.

Leukocratic (aplitic) granites (D. Kubíny 1956) differ by petrography from the previous granitoid types. They form smaller bodies of elongated shapes. Their confinement is more or less sharp, it follows approximately the shape of the pluton and is conform in the anisotropic granitoids with modal inhomogeneity foliation. Leukocratic granites may be mesoscopically isotropic or anisotropic. Those occurring in domains of anisotropic granitoids are usually anisotropic.

The boundary of porphyric K-feldspars crystallization is running regardless of the limits of the previously differentiated structural and petrographic types. It delimitates two large domains on NW and W of the pluton, where the most widespread rocks were designated as Prašivá granites (J. Koutek 1931). The NW domain is more heterogeneous as the western one. It is built of isotropic, as well as of anisotropic granitoids and it confines a smaller domain devoid of porphyric K-feldspars. The western domain bordered by faults is made up mainly by isotropic granitoids. The crystallization boundary of the porphyric K-feldspars is unsharp. Its primary course follows partially the shape of the pluton and on the east it is meander-shaped. These features prove for the younger crystallization of the porphyric-K-feldspars, irrespective of the older pluton structure represented by domains of isotropic, anisotropic and leukocratic granitoids.

3.2 *Fabric of modal inhomogeneity foliations*

The diagram in fig. 6 illustrates the orientation of modal inhomogeneity foliations in the domains of anisotropic granitoids. The single maximum corresponds to foliations of the general E-W strike and N dip. Large deviations from this orientation are rare (e. g. on distal ends of the pluton). Foliation course, however, is neither planar, nor rigorously isoclinical, but undulated with 0.1—1 km amplitudes. The foliation macrofabric of anisotropic granitoids is conform with the primary contact of the exposed mantle, as well as with the macrofabric of its migmatite foliations (compare the diagrams in figs. 6 and 7).

Fig. 6. Orientation diagram of modal inhomogeneity foliations in domains of anisotropic granitoids. 106 poles, interval 0-3-6 < %.

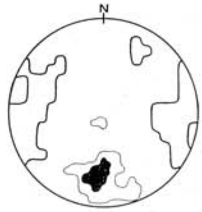

Fig. 7. Orientation diagram of schistosity in mantle migmatites from the S border of the pluton. 192 poles, interval 0-3-6 < %.

3.3 *The fabric of enclaves and veins*

Macroscopic and mesoscopic enclaves were found only in domains of anisotropic granitoids, particularly near the contact with the mantle. Enclaves of 100—1000 m sizes made up of migmatitized paragneisses of the same petrographic and structural characteristics as in the southernmore mantle, appear as far as 2 km from the margin. Their boundary towards the granitoids is unsharp with gradual transition. Schistosity of the enclaves in mesoscopic domains conform with granitoid foliation, displays in the macroscopic domain of the pluton more heterogeneous fabric than the modal inhomogenity foliation. The maxima in the orientation diagrams are, however, close (figs. 8 and 6)[2]. From the found enclaves the proximity of the eroded mantle in the southernmost parts of the pluton (S and NW from the village Magurka and in the environment of Vyšná Boca) and in the Mesozoic basement unfar from the northern margin can be suggested.

Aplite and pegmatite veins appear more often in domains of anisotropic than in isotropic granitoids, particularly near the contact with the mantle and in the vicinity of leukocratic granite bodies. Their orientation in the pluton is illustrated by the diagram in fig. 9. The symmetry of vein and modal inhomogeneity foliations fabrics is close. Mesoscopic structure relations and the mineral composition prove for heterocyclic formation of the veins.

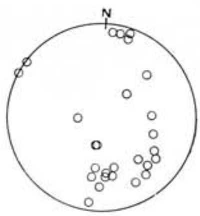

Fig. 8. Orientation diagram of schistosity in enclaves of the pluton. 27 poles.

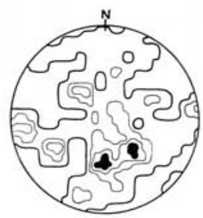

Fig. 9. Orientation diagram of aplite and pegmatite veins. 42 poles, interval 0-3-6-9 < %.

3.4 *Faults*

The postcrystalline pluton deformation is allied to the origin of the structure. The majority of the significant faults is accompanied by mylonitization of the adjacent rocks. Its intensity and extent depend on the fault type and dimensions. The foliations of postcrystalline deformation are parallel with the reverse faults of E to NE strike (figs. 10 and 11). In addition to the mylonitization zones the faults mark also springs of mineral and natural waters, the morphology of some valleys and saddles, owing to selective weathering of crushed rocks and ofsets of geological boundaries.

Faults in the investigated region may be divided formally in those limiting and those cutting the pluton. The *limiting faults* are usually of the overthrust (E and N boundary), or reverse fault type (W and a part of the S boundary). In these dislocations overthrusting of the nappe Mesozoic, eventually thrusting of the Kraklová crystalline complex on the granitoids and on their autochthonous Mesozoic envelope and thrusting

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[2] Differences in the diagrams are due to number of measurements and sampling. The rotation effect of smaller enclaves and of bending of modal inhomogeneity foliation around macroenclaves cannot be excluded.

Fig. 10. Orientation diagram of postcrystalline deformation foliations — spaced cleavage A. 74 poles, interval 0-3-6-9 < %.

Fig. 11. Orientation diagram of postcrystalline deformation foliations — spaced cleavage B. 37 poles, interval 0-2-4 < %.

of the granitoids on the autochthonous Mesozoic envelope (W boundary) and of a part of the metamorphic mantle rocks on the granitoids (central and W part of S boundary) set in.

The fault of the western part of the southern pluton boundary was less known and its interpretation is different. A fault was placed on the whole S boundary, along which a reverse fault of granitoids on crystalline schist generated and it was considered to be a reactivated intrusive contact plane (V. Zoubek In T. Buday et al. 1961, Geological map of ČSSR 1 : 200 000, sheet M-34-XXVI, 1964). In fact the faults appear locally only on the southern boundary of the granitoids with the mantle and belong at least to two northeastward and eastward striking systems. The NE system does not only border the pluton, it is running also beyond the mantle and crosses the pluton. Its mylonitization zone traced appr. on 26 km, includes in places several dislocation planes marked by polymylonization and gouge. Its width varies from several metres up to several 100 m and on four sites the envelope Mesozoic is inwedged (see the structural map). Fault plane dip varies in the range of 45°—90°, the medium dip to SE predominates. The hanging (SE) wall was comparatively shifted northwestward. East of the elev. point Kotliská (1936, 7) another eastward striking fault system terminates on the fault, accompanying the Mesozoic envelope infolded near to the southern boundary of the pluton. The kinematic characteristics of the described fault is similar to the central and southern tract of the Čertovica fault.

The Čertovica fault (V. Zoubek 1935) delimitates the eastern end of the pluton covered by the Mesozoic envelope and contacts the granitoids on two shorter sections only. The contorted shape of the fault line is the result of the conic-shaped fault plane incision. The dislocation plane dip is variable (20° to 90°). It is lowest in higher topographic levels. General dip increase seems to be due to jounger fault plane rotation by means of compression and elevation of the granitoids.

The overthust plane of the Mesozoic on the granitoids and their autochthonous Mesozoic mantle on N and NE of the pluton is gently dipping northward (10° to 40°). Mylonitization of granitoids which might have generated by overthrusting is not recognizable. Translation occured likely in the plastic simultaneously reduced Low Triassic beds.

The faults limiting the pluton towards NW and W are predominantly of NE strike and SE dip. They caused thrusting of granitoids on the NW Mesozoic envelope and on granitoids. In domains of intensive mylonitization with a slightly dipping fault plane accompanied by the inwedged Mesozoic envelope autochthonity of the overlying granitoids is dubious. This concerns mainly the western end of the pluton between the elev. points Príslop (1098,7) and Skalka (1548,7). That is why we agree with the basis of J. Koutek's (1931) interpretation of granitoid structure, according to which they build on these sites digitations and more eastward (beyond the area investigated) even recumbent macrofolds lying on the Mesozoic envelope. The northeastward continuation of the faults is probable, not proved, however, owing to unsufficient exposure. Thus the existence of the fold inferred by J. Koutek (1931) on the area close to the elev. point Solisko (1522,5) cannot be confirmed.

The faults cutting the pluton are of two types. Reverse faults of NE to E strike are similar to one part of the limiting faults. They induce intensive mylonitization in the granitoids and some of them are accompanied by the inwedged Mesozoic envelope. Strike slip faults and normal faults of NNE to NNW strike are younger than the reverse faults, they do not affect extensive mylonitization and do not comprise the Mesozoic envelope.

An significant reverse fault system appears in the eastern part of the pluton on the northern slopes of Ďumbier (2043,1) and Rovná hoľa (1722,6). Two subparallel faults accompanied by lenses of the Mesozoic envelope are doubled westward by reverse faults. The mylonites of the W part of the faults contain Cu mineralization (D. Kubíny 1956). On the W the rewerse faults terminate by a radial fault, on the E in the nappe basement.

Another, again ENE striking and S dipping reverse fault occurs in the W part of the pluton (S of Magurka). It is shifted on several sites by younger faults and carries polymetalic mineralization (J. Koutek 1931, J. Koutek — Z. Pouba 1957). Smaller reverse fault related with structures of Mesozoic envelope occur also east of the elev. point Veľ. Chochula (1753,0) and NE from Vyšná Boca settlement.

Younger strike slip faults and normal faults of NNW to NNE strike disturb on many places the boundaries of rock varieties of the pluton and the older faults. They are marked usually by undirect indications only and are covered by alluvium and debris. They were found e. g. in the vicinity of Vyšná Boca, N of Chopok (2023,3), SW of Dechtárska h. (1205,5) and S and E of Magurka.

3.5 *Mesozoic envelope structures within the pluton*

Low Triassic epiquartzites and sericite slates, as well as Middle, sporadically even Upper Triassic carbonates are present on several places in the internal domains of the pluton. These occurences, described in former papers (A. Matějka — D. Andrusov 1931, R. Kettner 1931, J. Koutek 1931, A. Matějka 1932), belong to the Ďumbier envelope group (M. Maheľ et al. 1967). From mesoscopic structures bedding cleavage, folds and flexures with subhorizontal axes as well as low density ac—cleavage were found sporadically. Bedding cleavage and fold axes are conform with the shape of macroscopic structures. They are similar to lenses and boards isoclinally located in the granitoids. They are, as a rule, rimmed by a mylonites marking the reverse fault. In some cases it is evident that these are macrofold relics destructed by shear parallel with the axial plane under simultaneous squeezing out of less competent rocks and reverse faulting.

From structure orientation, their destruction stage and mylonitization extent it is probable that the macrostructures have generated under different deformation regimes. In the E part of the pluton they were formed in a deeper structural level, with direction of maximal stress towards NNW and the heave of fault was smaller. In the W part deformation acted in a shallower level, the direction of maximal stress was towards W and thrusting was greater. In this part the coherence of the described structures with thrusts of the western margin of the pluton is conspicuous.

3.6. *Joint fabric*

Joints were studied in 8 subdomains (fig. 12). Their fabric seems at first sight rather unhomogeneous (also with regard to the numerous maxima in the diagram with less measurements). Some joint systems are in fact oriented uniformly in the whole pluton. This is the system of the almost vertical joints of NW to N strike. Another system with medium SE dip and NE strike appears preferably in the W subdomains (2, 3), but may be found however, also in the E (7). The third more abundant system is of similar strike like the latter, its dip, is, however, almost vertical. We may find it in the western and central subdomains.

The formation of these main joint systems may be interpreted in the same deformation plan, in which originated Alpine structures of the Mesozoic envelope. Its maximal stress direction in E of the pluton was from SSE and in the W from SE to E. In the individual subdomains overlapping of two systems may be recognized, in others a single is predominating. In some subdomains a couple of conjugated vertical joints is conspicuous, with the bisector of the acute angle in direction of maximal stress (e. g. subdomains 4, 5). In easternmore subdomains one set predominates. In the westernmore subdomains conjugated joints are overlapped by a NE trending system with medium dip to SE. This system is parallel with the foliations of postcrystalline deformation, their origin is closely related and was formed likely by compression and simultaneous relief. One part of the joints originated evidently by decompression due to release of residual stress during uplifting and erosion, though horizontal joints are rare.

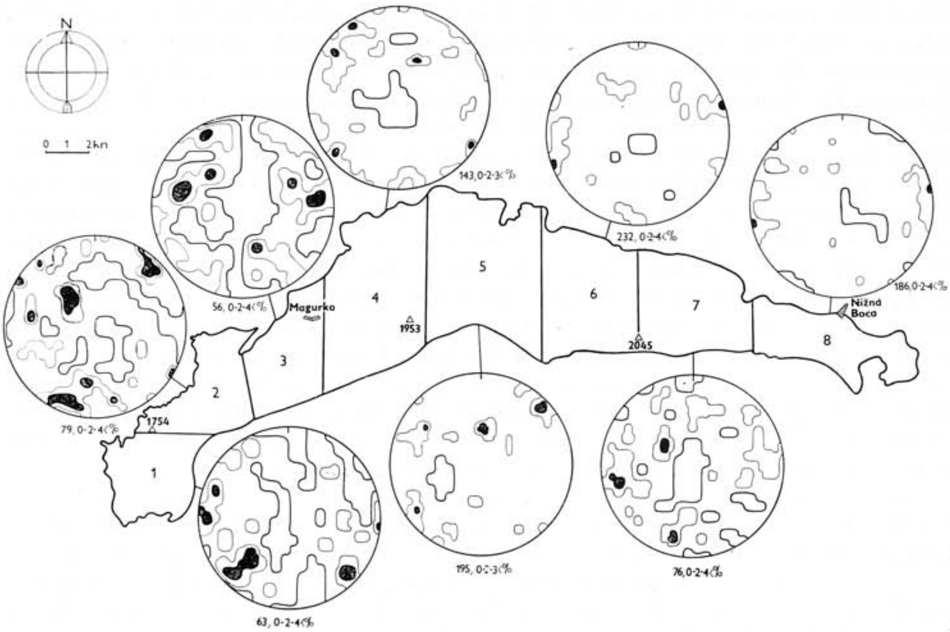

Fig. 12. Orientation diagrams of 1030 joints in the pluton. Number of measurement and interval marked at the diagrams.

3.7 *Shape of the pluton*

From the course of the boundary and from the fabric the shape of the pluton may be estimated up to an unsubstantial depth of the recent exposure level. The boundary shape in the plane reminds a wider boomerang. The primary boundary is in fact the centre of the zone of gradual transitions of stromatic and nebulitic migmatites into hybrid granitoids. It builds the major part of the southern boundary and only two short sections of the northern boundary, which might be even large enclaves. Its N dip is steeper from S (50° to 80°) than from the N side (40°).

The secondary boundary made up by faults sets the exposure shape of the major part of the pluton. Generally it does not confine the body towards depth and the granitoids appear also in the basement of low angle reverse faults and nappes (e. g. in the direction of the pluton elongation). Orientation of the primary foliation and the enclaves is approximately parallel with the primary boundary of the pluton. Macroscopically the pluton is an anisotropic and primary conform elongated body, at present steeply dipping northward. The recent body shape and its outcropping are substantially determinated by Alpine deformation.

4. *Discussion*

The most important primary structure is modal inhomogeneity foliation. The notion on its genesis throws light upon the origin of the granitoids. The mineral composition and foliation fabric related to the enclave and migmatite foliations fabric does not prove for typical layering (L. R. Wager — G. M. Brown 1967). In microdomains only biotite is apparently oriented (K. Siegl 1970). Its fabric may be interpreted either as relic after metamorphic rocks foliation (palimpsest), or such generated by magma flow. The first case seems very likely in the marginal zones of the anisotropic domains. The transitions into migmatite foliations are gradual and their fabric is homotactic with the fabric of the modal inhomogeneity foliations. The second case of orientation by magma flow could rather apply in the more internal domains of the pluton. Flow in the high-viscose (nonliquid) medium must have been slow. Flow lineations, regarded by some authors along with the dome structure of flow foliations (e. g. E. Nickel — H. Kock — W. Nungässer 1967) as a convincing evidence for the orientation by magma flow, were not found. Considering the deformation of the dome structure by Alpine compression, mesoscopic flow lineations would be surviving. Against the fluidal stage of the magma speaks also the ellipsoidal enclave shape, their eventual S-like rotation and the lack of differentiation features.

A part of the leukocratic granites was evidently more mobile, analogously as the aplites and pegmatites. In the upper parts of the pluton they may be mesoscopically discordant to the older primary structure of the anisotropic granitoids or macroenclaves, or make up in the mantle the polymigmatite neosom[3].

The likely palimpsest origin of the majority of primary foliation and the features of reduced mobility of the magma prove of peacefull emplacement and rather autochthonous mobilization, than forcefull intrusion of the allochthonous magma. This is confirmed also by the composition and distribution of the found enclaves. Xenoliths, skialiths and micaceous enclaves are of restite type and exogenous origin. Many of them were reworked in the anatexis and contain sillimanite, similarly like the metamorphites of the close mantle.

The fabric of modal inhomogenity foliations and enclaves confirms also the alliance of its forming with the deformation in the mantle. The symmetry of the fabric diagrams of granitoid and migmatite foliations is identic. Rare mesoscopic folds in the foliation of modal inhomogeneity are homoaxial with the pre-Alpine migmatite folds. Similar relations are valid also for biotite subfabrics in a part of the isotropic domains (K. Siegl 1970). For this reason the major part of the granitoids may be designated as syntectonic. In the part of the isotropic granitoid domains there were not found reasons for this designation. The relations crystallization — deformation are derived

[3] The last case partly corresponds with the rocks described as "migmatites of the Ďumbier granite" (V. Zoubek In: D. Andrusov — J. Koutek — V. Zoubek 1951) and "migmatites of the contact-near zone" (D. Kubíny 1956).

particularly from mesoscopic and microscopic biotite fabric and from the structures marked by it. The designation "syntectonic" is applied thus particularly to fabric forming of biotite, one of the oldest mineral components. Precise determination of feldspars and quartz fabric forming is not known (also owing to postcrystalline deformation). At least in isotropic granitoids it seems to be posttectonic. The denomination "late-syntectonic pluton" seems us to be the most suitable considering Variscan formation of all domains of the body.

The evaluation of Alpine deformation of the pluton is another problem. Plastic deformation of quartz in the investigated microdomains is penetrative. Postcrystalline deformation of the other components is nonpenetrative. It is concentrated on the pluton margin and near of the Alpine macrostructures, where it is accompanied also by recrystallization. Althoug the shape and the major part of the macrostructures underwent Alpine reworking this cannot be stated about mesoscopic fabrics in apparently Alpine undeformed domains. For the present we do not know to what degree the macrofabric of modal inhomogeneity foliations was deformed. In metamorphic rocks of the southern mantle reorientation of the foliations can be perfect owing to Alpine refolding (K. Siegl 1973, 1974). The thickness of the Mesozoic sediments covering the pluton prior to thrusting of the nappes was 1,5 km at least and in time of thrusting even three times more[4]. The deformation regime of the granitoids acted under p-t conditions of the greenschist facies, in which the sediments of the Low Triassic envelope are metamorphosed. According to J. G. Holland — R. Lambert (1969) similar and isoclinal folds in all scales generate in this regime, the same as are found in the infolded Mesozoic envelope e. g. in epiquartzites. It is most probable that in domains of intensive Alpine compression folds generated also in granitoids.

In the present state of knowledge it is not possible to distinguish Variscan and Alpine structure of brittle fracture. The similarity of both deformation plans and complexity of Alpine deformation are the main handicap. The analogy with a similar problem in the southernmore metamorphites enables to infer in some cases conform overprinting and "reusing" not only of structures of two orogenes, but also various deformation phases of the same.

5. *Conclusion*

The Low Tatra pluton is by material and structure a heterogeneous body. Material heterogeneity originated by assimilation, differentiation and by metasomatism of granitoids. Mafic varieties of anisotropic granitoids originated by assimilation of the mantle, one part of the leukocratic granites, aplites and pegmatites by differentiation, granites rich in K-feldspars and likely the minor part of the leukocratic granites by metasomatism. Metasomatism is younger than primary structural heterogeneities and does not respect their macrofabric.

Structural heterogeneity is due to the presence of domains lacking and others comprising mesoscopic foliation of modal inhomogeneity. It is the oldest granitoid structure. It is conform and homotactic with the foliation of the mantle migmatites and with the majority of exogenous enclaves. Flow lineation and dome-like structure of foliations were not found. The anisotropic domains with foliation surrounded originally isotropic domains lacking foliation and formed the transition between the granitoids and the mantle migmatites. This arrangement was disturbed in one part

[4] Calculated from the stratigraphic column of M. Mahel' et al. (1964).

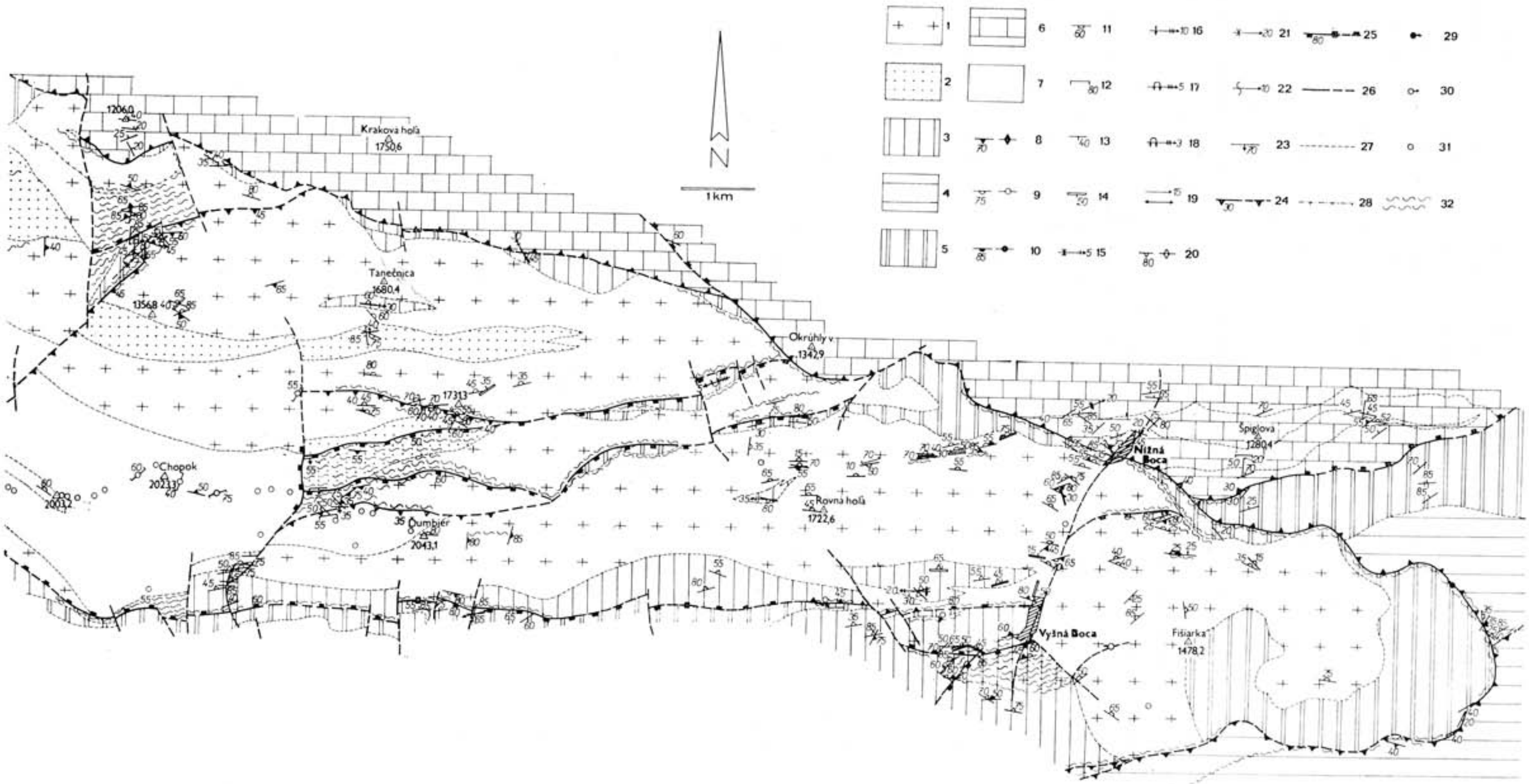

Fig. 14. Structural map of the eastern part of the Low Tatra pluton. A part of the geological boundaries according to maps of J. Koutek (1931), D. Andrusov — J. Koutek — V. Zoubek (1951) and D. Kubíny (1958). Explanation as in fig. 13.

of the pluton by masking of anisotropy by metasomatism and postcrystalline deformation. By postcrystalline deformation new material and structural heterogeneities generated, as mylonites, folds, cleavage, faults and joints.

The composition, the primary Variscan structure of the pluton and its relation to the structure of the metamorphic mantle prove for the peacefull catazonal late-synkinematic emplacement of the likely palingenous magma. The pluton was uplifted and exposed up to the Lower Triassic under the formation of one part of the faults and joints. In the Lower Triassic it was incorporated to the Alpine geosyncline and covered by sediments. Compression in longitudinal direction, starting probably already in the Jurassic, induced refolding of the granitoids along with the metamorphic mantle and the sediments. With alteration of the structural level owing to elevation and relief the macrofolds grew over to reverse faults. Simultaneously the majority of foliations of postcrystalline deformation originated and later even most of the faults and joints. The orientation of the Variscan and Alpine deformation plans was similar and one part of the faults and joints is overprinted conformly. The shape and the macrofabric of the pluton has developed principally by Alpine deformation.

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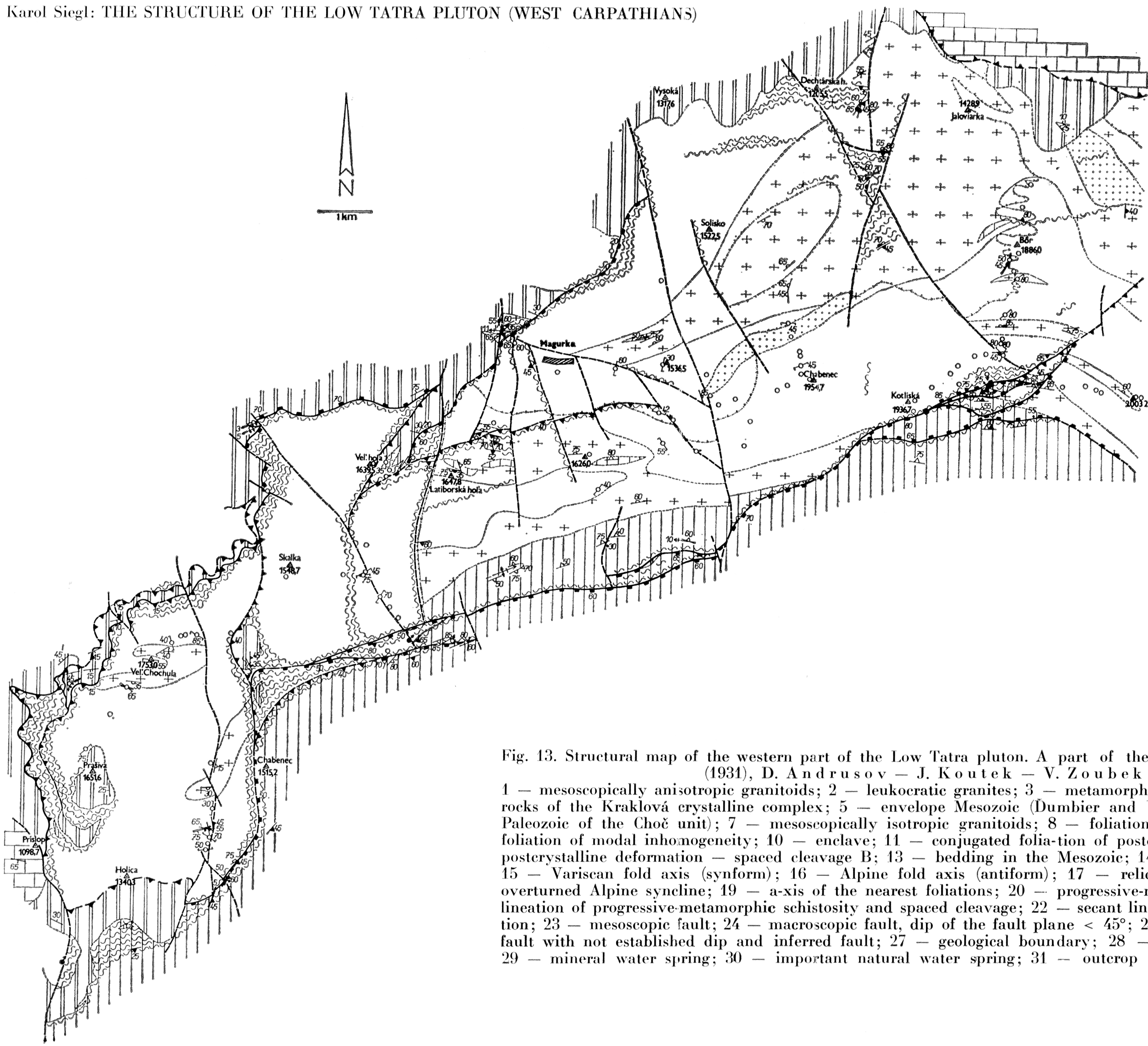
Review by L. KAMENICKÝ.



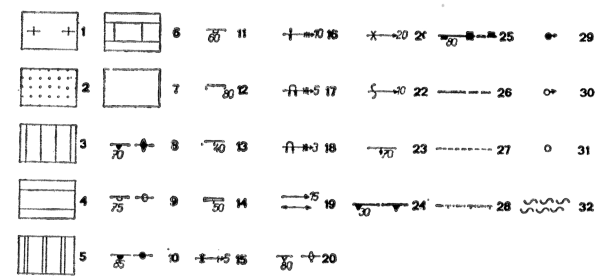


Fig. 13. Structural map of the western part of the Low Tatra pluton. A part of the geological boundaries according to maps of J. K o u t e k (1931), D. A n d r u s o v — J. K o u t e k — V. Z o u b e k (1951) and D. K u b í n y (1958).

1 — mesoscopically anisotropic granitoids; 2 — leukocratic granites; 3 — metamorphic rocks of the Ďumbier crystalline complex; 4 — metamorphic rocks of the Kraklová crystalline complex; 5 — envelope Mesozoic (Ďumbier and Veľký Bok group); 6 — nappe Mesozoic (incul. the Upper Paleozoic of the Choč unit); 7 — mesoscopically isotropic granitoids; 8 — foliation of postcrystalline deformation — spaced cleavage A; 9 — foliation of modal inhomogeneity; 10 — enclave; 11 — conjugated folia-tion of postcrystalline deformation (in the fault zone); 12 — foliation of postcrystalline deformation — spaced cleavage B; 13 — bedding in the Mesozoic; 14 — aplite or pegmatite vein (thicknees more than 10 cm); 15 — Variscan fold axis (synform); 16 — Alpine fold axis (antiform); 17 — relics of the overturned Alpine anticline; 18 — relics of the overturned Alpine syncline; 19 — a-xis of the nearest foliations; 20 — progressive-metamorphic schistosity in metamorphic rocks; 21 — secant lineation of progressive-metamorphic schistosity and spaced cleavage; 22 — secant lineation of two conjugated foliations of postcrystalline deformation; 23 — mesoscopic fault; 24 — macroscopic fault, dip of the fault plane < 45°; 25 — macroscopic fault, dip of the fault plane > 45°; 26 — fault with not established dip and inferred fault; 27 — geological boundary; 28 — crystallization boundary of pink mesoscopic K-feldspars; 29 — mineral water spring; 30 — important natural water spring; 31 — outcrop in mesoscopically isotropic granitoid; 32 — mylonization.